REMARKS

This responds to the Office Action dated December 4, 2006.

In the Office Action, claims 1-44 are noted as pending in the application, claims 1-44 stand rejected, no claims are objected to and no claims are allowed. No claims have been withdrawn from consideration.

Status of the Claims

Claims 1-44 are pending in the application. New claims 45-57 have been added and claim 7 is canceled without prejudice.

Rejections

The Office Action rejects all pending claims 1-44 and discusses each claim separately, which Applicant appreciates. Each rejection of the Office Action also cites to particular portions of the cited reference under consideration. However, not all of the citations to the references relate to the particular rejection for which the citation is made, which means that no support is given in the Office Action for the rejection. Additionally, as to those rejections, the undersigned representative has been unable to locate in the cited reference after reasonable review any support for the particular rejection. For example, the rejection of claim 6 recites "*Al-Hussein* discloses the method (fig 1-5), wherein the step of characterizing includes the step of identifying pixels representing color information; see (col. 18, lines 1-15)." However, the citation says nothing about color, and upon review, nothing elsewhere in the cited reference supports the rejection. The rejections which lack any support because the citations are erroneous are the rejections for at least claims 6, 7, 18, 19, 21, 35, 37, 39, 40, 41, 42, and 43. Therefore, the rejections of these claims fail without more, and the rejections of these claims should be withdrawn. While one or more other arguments herein may also apply to overcome these rejections, these rejections should be withdrawn without more because the Office Action fails to support the rejections.

In the Office Action, the claims are rejected as being allegedly obvious over *Al-Hussein* (USP 5,818,978) in view of *Luther et al.* (USP 6,449,065). Necessarily, neither

of the references alone teach or suggest the claimed combinations, and the rejections must necessarily rely on at least two references for teaching or suggesting the claimed combinations. In the present application, however, the combination of the references as argued in Office Action does not produce the claimed inventions, as demonstrated below.

Applicant's Disclosure

Consider first Applicant's disclosure. Applicant discloses methods and apparatus are described for analyzing images, for example to permit image segmentation, recognition of image interior portions, improved image enhancement, and/or to permit data compression or other processes. One or more of the methods permits easier image characterization, for example at multiple levels, allows disassembly of image layers or segments, takes into account a number of color attributes, can make easier such image enhancements as edge sharpening, selective and uniform image enhancement, color and black and white enhancement or enhancement of color text. More precise image rendering is possible, and image enhancement based on image content can be improved. Image processing can also be improved, for example, by removing or modifying color anomalies that may have been generated in an otherwise black and white, text document, thereby making printing of the black and white document on an inkjet printer more efficient by reducing the use of color ink cartridges. In one application of one of the present inventions, image characterization can be used to identify an image such as one from a scanner as one of either all text, all graphic or picture, or a mixture of both text and graphic. Such information can then be used to establish scanner settings, parameters used in image enhancement, as well as for other purposes.

Considering the image analysis and characterization step in more detail, in one form of a process for analyzing an image and characterizing the image as text only, picture or graphic only, or mixed, image data is received and elements of the image are characterized, preferably on a pixel-by-pixel basis. In one preferred embodiment, the image is segmented into regions or image segments, and in another embodiment the

image areas are analyzed to identify pixels according to a hierarchy, such as blobs and sub-blobs. In another embodiment, the image areas are analyzed to identify edge portions separate from other areas of the image, for example to allow edge enhancement, and in another embodiment, the images are analyzed to identify interior regions of an image that form a part of a larger part of the image. According to one embodiment, each pixel is characterized as either white, black or color using an appropriate standard, and in another embodiment, each pixel is characterized as either white, white edge, gray, gray edge, black, color or color edge. In one embodiment, the image analysis and characterization are carried out with one purpose being the identification of text-only images. In other situations, the analysis and characterization can be carried out in order to enhance the image, to compress the image or to segment the image for further processing.

The pixel image data is also analyzed to identify appropriate relationships between pixels, especially those pixels adjacent to each other. In one preferred embodiment, pixels that are adjacent each other and that have the same characterization, such as black, white or color, are then grouped, aggregated or linked to each other and identified as connected regions, sometimes referred to as blobs. In the preferred embodiments, the characterization of parts of the image as being related is intended to recognize and take advantage of the fact that related parts of an image will have identical or similar characteristics, or at least sufficiently similar to allow those parts of the image to be treated together, either in terms of enhancement, segmentation or separation or for other purposes. For example, regions of all black text will share the characteristics that the pixels will be either black, white or relatively sharp or steep transitions between those two extremes, and black regions and white regions will be relatively uniform in intensity or luminance. On the other hand, pictorial or graphic regions, represented in gray scale, will have substantially more gray areas, softer or smoother transitions between light and dark and comparatively fewer aggregations of black and white pixels. Therefore, in the preferred embodiments, the pixels are not only analyzed for their content but also their relationship to adjacent and nearby pixels.

In one example, the image data is then processed line-by-line, and preferably on

a pixel-by-pixel basis, to analyze and characterize each pixel, and, if possible, to group the pixels. The image data is checked for background levels so that digital values corresponding to true white and true black can be established. Digital values in between will be assigned different gray scale values, and gray values may be assigned using a threshold determination, such as anything between 0.5 and 0.95 times the value of the white pixels. Black may then be anything equal to or below 0.5.

The CPU uses a gradient operator 116 to determine if a given pixel represents or is immediately adjacent an edge. The processor checks to see if the data is going from light to dark or dark to light and provides a representation as to the amount of change and the direction of change. The direction of the change will indicate whether the data is going from light to dark or from dark to light. The processor then determines whether or not the change is significant or large enough to represent an edge or is slight enough to represent the more gradual changes present in photo or graphic images.

The threshold or thresholds established by the processor and the gradient values corresponding to the pixels in the line being analyzed are then used by the processor to characterize 118 each pixel. Using the threshold and the indication of whether or not the pixel is on an edge, the processor decides whether each pixel should be characterized as white, black or gray or color. If the pixel is above the threshold, it will be characterized as white, and if it is at a digital value at the other end of the spectrum (below the gray threshold), it will be characterized as black. If it is in between, and the gradient value is small (below the gradient threshold, such as below 30) or otherwise indicating a gradual change, the pixel is characterized as gray scale or color. The characterization of each pixel is then stored, along with the gradient value, if desired. Additionally, each pixel can be assigned one of more than three values, in other words intermediate values in addition to black, white or gray or color. For example, possible labels for each pixel may include dark gray, light gray, black, white, color, gray edge, color edge or other useful characterizations. The labels or characterizations and their number may depend on what the characterizations ultimately will be used for and the desired quantity and precision desired for the data.

Preferably after the pixel classifier, the processor analyzes 120 the connectivity

or relationships among pixels to identify connected regions or areas of pixels that can be characterized the same or sufficiently similar to represent one type of pixel. For example, if one or more pixels immediately adjacent a given pixel has the same label, or a label that is sufficiently close to be characterized as the equivalent, those pixels will be grouped, separated or otherwise combined into one region type or other characterization. For example, all adjacent pixels labeled black may ultimately be identified as text, especially if there are a significant number of adjacent pixels that are labeled white. However, if those pixels labeled black are in or surrounded by regions of different gray scale levels, those pixels as well as the gray scale level pixels may be identified as a graphic or pictorial region, and possibly color text.

With the information from the connectivity analysis, the processor can then characterize 122 each region or blob. The processor can then tabulate, sum or otherwise account for the relative numbers of text, graphic or other characterizations of regions. The image can be processed or stored, as desired. For example, where the application or destination of the image is known, the processing of the image can be completed. Where the image is to be enhanced, the text regions can be edge sharpened and the text characters made all black. The color regions can be smoothed and some color manipulation can also be done, if desired. The text and graphic regions can be compressed as well.

In one example of image analysis, the process uses three sequential steps, which will be called pixel classification, hierarchical connected component (HCC) analysis and region or blob classification. Pixel classification preferably identifies or uses image features to distinguish the different parts of the image. In example where the image data is analyzed in gray scale form, those features are representations of black and white values, edge elements, and the balance, which will be called gray. In an example where the image includes color data, the features used to characterize each pixel may be black, white, white edge, gray, gray edge, color and color edge. Other features or image characteristics may be used to differentiate parts of the image, but it is believed that these are particularly appropriate for many of the images that would be encountered in ordinary practice. Hierarchical connected component (HCC)

analysis and region or blob classification are described in Applicant's specification. Examples of the applications of these processes are also provided in Applicant's specification.

Cited Prior Art

All the references relied upon in the Office Action are strictly binary processes. The pixels in the image are converted to binary either black or white. Hussein teaches an image pre-processor for character image recognition. The system scans a document and obtains a gray-scale image of the document. The system then generates a binary image and compares the gray-scale image with a threshold to segment the binary image into individual characters and to determine the shape of the individual characters. Gray-scale image information is extracted from the gray-scale image for each individual character based on the location and shape of the character in the binary image, and the image information is recognized to determine the identity of the character. Because the system operates on a binary image, the data representing the gray scale image is necessarily characterized as either black or white, and no other image characteristics are identified with pixels. The binary image is used to move under lines and to obtain connected components within a binary image. The system also uses the binary image to separate text-type components from non-text type components so that only text-type connected components can be processed for character recognition. As acknowledged in the Office Action, Hussein does not disclose identification of an element having a given characteristic that is adjacent another element having a characteristic approximately the same as the given characteristic. However, the secondary reference cited in the Office Action does not provide the missing subject matter.

The Office Action cites *Luther et al.* as the secondary reference, but *Luther et al.* does not teach or suggest claim elements such as identifying edge information, color information, gray scale information, or applying sub-labels to interconnected pixels. Specifically, *Luther et al.* teaches a method for capturing a document image and a document image management system. In the system, a scan provides by-level image

data analyzed to identify blocks of uniform image type, for example text, line drawing, gray scale image, or full-color image within the document. While the Office Action argues that *Luther* identifies each element having a given characteristic approximately the same as a given characteristic of an adjacent element, nothing in *Luther* or in *Al-Hussein* teaches or suggests such methods as detecting an edge using a gradient to detect an edge, detecting gray, and gray edge, or detecting white edge, gray edge, and color edge, to cite some examples.

Wang et al., U.S. Patent No. 5,680,479, teaches contour tracing, in conjunction with FIG. 4, at column 11, line 25, through column 12, line 27, and following. This patent is cited in *Luther* at column 10, line 37, column 14, line 60, column 16, line 57, and column 19, line 12. However, *Wang et al.* operates only on binary data. [See, column 8, lines 40-43 ("convert the non-binary pixel data into binary pixel data prior to storage in RAM 20").] Using the binary pixel data, the contour tracing does not find elements representing an edge but instead operates on binarized black pixels to develop a contour. It appears from *Wang et al.*, that on average, half of the pixels would be made black and half would be made white for those pixels in Applicant's process that would be identified as edge elements.

It is noted also that *Wang et al.* also defines a rectangle around each connected component, which has no relation to any actual edge configuration of a connected component. [See, column 11, lines 66-67.] It is also clear that *Wang* does not locate edges, because no interior portions of a component is traced. [See, column 12, lines 10-12, "interior portions of closed contours are not traced."] Therefore, *Wang et al.* would not even find an interior opening or edge thereof for the letter "A" or the letter "Q" as depicted in FIG. 5(a) of *Wang*.

As can be seen, all the references in the Office Action convert the pixels in the image to binary either black or white. No edge detection occurs. See, *Al-Hussein*, column 12, lines 45-51, and column 18, lines 9-13. See, *Luther*, column 7, lines 45-48 ("black and white (bi-level)", and column 10, line 38 and column 14, line 60 referring to the *Wang et al.* patent. See, also the *Wang et al.* patent, column 8, lines 40-43

("convert the non-binary pixel data into binary pixel data prior to storage in RAM 20"). Clearly, Applicant has taught inventions patentable over the references.

Claims

Consider now the claims in the application. Claim 1 is an independent method claim and recites in part:

> "receiving data representing a plurality of elements of an image;
>
> "characterizing each element in the plurality of elements according to a perceived characteristic corresponding to an edge; and
>
> "identifying each element having a given characteristic that is adjacent an element having a characteristic approximately the same as the given characteristic."

None of the cited references taken singly or in combination teach or suggest the claimed combination, the recited elements quoted above, or "characterizing each element in the plurality of elements according to a perceived characteristic including a characteristic corresponding to an edge". The cited references, singly or in combination, teach and suggest nothing about characterizing an element characteristic corresponding to an edge. The cited references are black and white pixel classifications, in a binary fashion. Clearly, claim 1 is patentable over the art.

The claims 2-21 are dependent directly or indirectly from independent claim 1 and are asserted as being patentable for the same reasons as discussed above with respect to claim 1, for the additional combinations in the dependent claims as well as for the additional limitations recited in the dependent claims. Note for example, claim 6 reciting in part "wherein the step of characterizing includes the step of identifying pixels representing color information". Note also claim 18 reciting in part "wherein the step of identifying each element that is adjacent includes the step of identifying adjacent pixels that are characterized as background, and further including the step of identifying adjacent pixels characterized as background and also characterized with a label".

Claim 19 recites in part "wherein the step of identifying each element that is adjacent includes the step of identifying adjacent pixels that are characterized as non-background, and further including the step of identifying adjacent pixels characterized as non-background and also characterized with a label".

Claim 22 is an independent method claim and recites in part:

> "identifying elements of the plurality of elements of the image that represent an edge of a portion of the image; and
>
> "identifying elements of the image that represent an edge and that are adjacent at least one other element representing an edge."

None of the cited references taken singly or in combination teach or suggest the claimed combination, the recited elements quoted above, or "identifying elements of the plurality of elements of the image that represent an edge of a portion of the image" or "identifying elements of the image that represent an edge and that are adjacent at least one other element representing an edge".

The claims 23-43 are dependent directly or indirectly from independent claim 22 and are asserted as being patentable for the same reasons as discussed above with respect to claim 22, for the additional combinations in the dependent claims as well as for the additional limitations recited in the dependent claims. Note for example claim 23 reciting in part "wherein the step of identifying elements of the image representing an edge includes the step of using a gradient operation on groups of pixels to determine if an individual pixel is part of an edge". Claim 24 recites in part "wherein the step of identifying elements of the image that represent an edge and that are adjacent includes the step of selecting a first pixel that represents an edge, and identifying a plurality of adjacent pixels, and identifying any of the plurality of adjacent pixels that represent an edge". Claim 27 recites in part "wherein the step of identifying any of the plurality of adjacent pixels that represent an edge includes the step of labeling the adjacent pixels that represent an edge with a unique label". Note also claim 33 reciting in part "wherein the step of identifying pixels having the same label that are connected includes the step

of applying a sub-label to the connected pixels that have the same label". Claim 43 recites in part "further comprising the step of counting the number of non-black pixels that are interconnected and comparing to the number of interconnected black pixels".

Claim 44 is an independent method claim and recites in part:

> "identifying elements of the plurality of elements of the image that represent an edge of a portion of the image; and
>
> "identifying elements of the image that represent an edge and that are adjacent at least one other element representing an edge."

None of the cited references taken singly or in combination teach or suggest the claimed combination, the recited elements quoted above, or "identifying elements of the plurality of elements of the image that represent an edge of a portion of the image" or "identifying elements of the image that represent an edge and that are adjacent at least one other element representing an edge".

The claims 45-49 are dependent directly or indirectly from independent claim 44 and are asserted as being patentable for the same reasons as discussed above with respect to claim 44, for the additional combinations in the dependent claims as well as for the additional limitations recited in the dependent claims. Note for example claim 46 reciting in part "further including identifying elements of the plurality of elements of the image that represent black, gray, and gray edge". Claim 47 recites "wherein identifying elements of the plurality of elements of the image that represent an edge of a portion of the image include identifying elements that represent one of a white edge, gray edge, and color edge". Claim 49 recites "wherein identifying elements of the image that represent an edge includes identifying elements of an image representing an edge using a gradient operation".

Claim 50 is an independent method claim and recites in part:

> "characterizing, as a function of the grayscale image data, elements in the plurality of elements according to a perceived characteristic wherein a perceived characteristic includes an edge characteristic . . . ."

None of the cited references taken singly or in combination teach or suggest the claimed combination, the recited elements quoted above, or "characterizing, as a function of the grayscale image data, elements in the plurality of elements according to a perceived characteristic wherein a perceived characteristic includes an edge characteristic".

The claims 50-57 are dependent directly or indirectly from independent claim 50 and are asserted as being patentable for the same reasons as discussed above with respect to claim 50, for the additional combinations in the dependent claims as well as for the additional limitations recited in the dependent claims.

Reconsideration of the application and claims in view of the foregoing amendments and remarks is respectfully requested. Early notice of allowance thereof is earnestly solicited.

This response is being filed with an Information Disclosure Statement and a One-Month Extension of Time.

If a petition is required in conjunction with this paper, please consider this a request for such a petition.

Respectfully submitted,

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